

Disruptive Tolerant Networking for Distributed Small Satellite Systems

Completed Technology Project (2011 - 2015)



Project Introduction

As NASA moves towards its objective to make missions more affordable and more capable, researchers are proposing to meet some space observation and communication needs via groups of small satellites, rather than by a single large satellite. Small satellites have low manufacturing and launch costs. However, functionality is limited by their distributed topology, low data-rate and single point-to-point, communication system. We propose a new space-based communication networking protocol for distributed small satellites, to allow a grouping of small satellites to behave as nodes in a network. We expect this approach will result in a higher data-rate downlink with longer transmission windows to a ground station. The key objective is to apply ad-hoc networking protocols to the topology of a distributed small satellite system used for earth imaging. The system would include small satellites in different orbits with inter-satellite links allowing data to be routed to ground stations. The space-based networking protocol would use disruptive tolerant networking concepts to manage the intermittent connectivity between satellites and the ground stations. Methods proposed to accomplish this project include designing hardware to comply with small satellite constraints of power, mass and volume. The space-based networking protocol would be developed using the disruptive tolerant networking (DTN) concept of store and forward, incrementally moving and storing data throughout the network to eventually reach its destination. This concept is often applied to networks that lack continuous connectivity. Replicating many copies of the message maximizes the probability of a message being successfully transferred. However, the replication causes more overhead data, increasing the bandwidth requirements. This tradeoff must be examined to find an optimal approach. The goal of the solicitation is to create innovative new space technologies for our nation's science, exploration and economic future. The proposed work will produce a new disruptive tolerant network designed for earth-observing small satellites. A distributed small satellite system, whether in a cluster of the same orbit or a constellation in different orbits, would encourage NASA missions that are impossible to realize on a single satellite or could be deployed to support/upgrade the operation of a large satellite. NASA has an interest in disruptive and delay tolerant networks. The internship component allows for collaboration with NASA centers that are participating in NASA's disruptive tolerant test-bed. From an earth imaging perspective, the new space-based networking protocols would provide more frequent images at higher resolutions in more regions. This is especially important when it comes to disaster monitoring. The realization of a high-speed communication network for small satellites would lead to many other low cost missions as well, sustaining our nation's excellence in science, and exploration for decades to come.

Anticipated Benefits

This work will produce a new disruptive tolerant network designed for



Project Image Disruptive Tolerant Networking for Distributed Small Satellite Systems

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

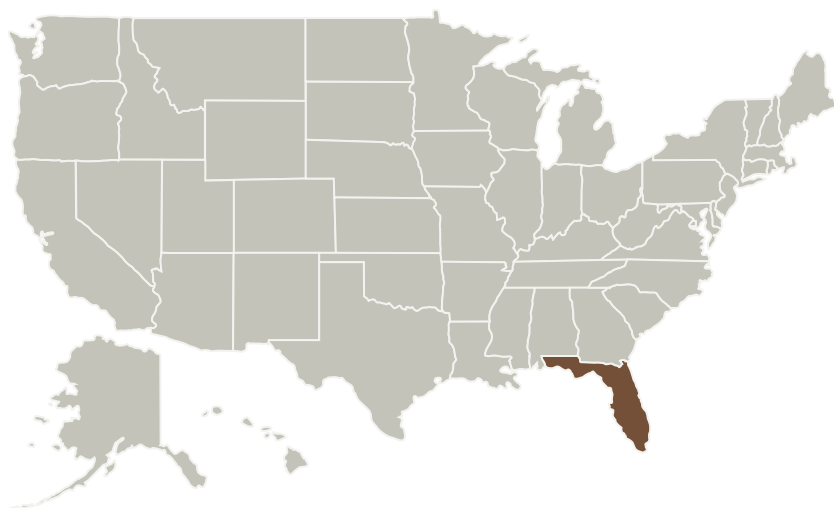
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Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations

Florida

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

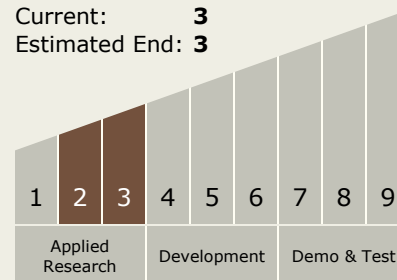
Janise Mcnair

Co-Investigator:

Paul D Muri

Technology Maturity (TRL)

Start: 2
Current: 3
Estimated End: 3



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
 - └ TX05.3 Internetworking
 - └ TX05.3.1 Disruption Tolerant Networking

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Images



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Project Image Disruptive Tolerant
Networking for Distributed Small
Satellite Systems
(<https://techport.nasa.gov/image/1759>)

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>